

**Notes on the Bionomics and Distribution of the  
Genus *Stenopelmatus* in Central California  
with the Description of A New Species**  
(Orthoptera : Gryllacrididae)

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During the course of the first author's studies in Nearctic Desert Sand Dune Orthoptera series, the discovery of a new genus and several new species of arenicolous stenopelmatine crickets necessitated a study of the genus *Stenopelmatus* Burmeister. These studies, begun in 1952, were greatly aided by four National Science Foundation grants during the years 1957-1960. To date ten parts have been published in this series including the description and bionomics of the above mentioned new genus.

The new species discussed in this paper was first recognized by the second author while curating Orthoptera in the California Academy of Sciences. Three specimens collected by E. C. Van Dyke at Coalinga, Fresno County, California provided the impetus for further investigation. Mr. Lee D. Wilson, then a California Department of Agriculture entomologist living in the area, made several trips with the second author and aided in locating the habitat of the species.

LIFE HISTORY AND DISTRIBUTION OF *STENOPELMATUS*

Hebard (1916) was the first to suggest that the life cycle of species of *Stenopelmatus* extended over a period of several years. As a result of numerous rearings, we can now definitely confirm Hebard's early observation.

If second or third instar nymphs are collected in the field and brought into the laboratory they take up to four or five additional years to mature. Immature specimens are placed in individual jars and fed lettuce and oatmeal. All species studied, including the new species, took similarly long periods of time to mature. It is believed that six or more larval instars occur in the species of this genus. The exuvium may be either eaten or not eaten after molting.

Frequent confusion in the past, and the resulting large number of synonyms, has existed due to the failure of students of the group to recognize adult specimens of *Stenopelmatus* species. The multi-annual life history and wingless condition of the adults further adds to the confusion. There is still no known certain way to determine from

TABLE 1. Seasonal occurrence of species of *Stenopelmatus* based on adult and near adult specimens, mostly males. I-indicates initial record of adult activity, F-indicates final record. See discussion.

(S. intermedius)					(S. intermedius)						
----- F					I -----						
(S. pictus)					(S. longispina)						
I ----- F					I ----- F						
(S. fuscus)											
I ----- F											
Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.

external features whether a specimen is an adult. Hebard (1916) was the first to discover that adult and last instar males possess hooks on the dorsolateral margins of the supra-anal plate. These hooks appear as swellings or ridges in earlier instars. Adulthood of females cannot be determined with certainty. Only an estimation of overall size and development of the ovipositor can help to determine the maturity of females. Investigation of the development of the internal reproductive organs (testes, ovaries) might be of great use here.

An attempt was made to determine if geographical separation of species existed. This was accomplished by examining specimens in the California Academy of Sciences, California Insect Survey, and the authors' personal collections, and then plotting the distributions. At once tendency towards sympatry became apparent, especially in the San Francisco Bay Region. Figure 1 shows the distributions of the species. It must be noted that this map represents the specimens available to us at the time of the study and must not be taken to represent the complete range of the species involved or the distribution of the species in California. Other specimens, which were not seen, exist in various collections and this group of insects is under study at The University of Michigan. The genus has a broad distribution in the state. Our map only represents what we feel is a likely trend towards sympatry in the distribution of the species in central California.

With such sympatry indicated, one immediately seeks to discover isolating mechanisms. Some ecological separation seems to exist. *S. longispina* seems to be limited to coastal areas and is frequently associated with chaparral; *S. intermedius*, apparently closely related to *S. longispina*, is found at lower elevations in sandy areas but in relatively the same geographic area. The large species, *S. fuscus*, occurs more inland and seems to inhabit a wide variety of habitats. Although described from San Francisco, *S. pictus* is likely found only inland

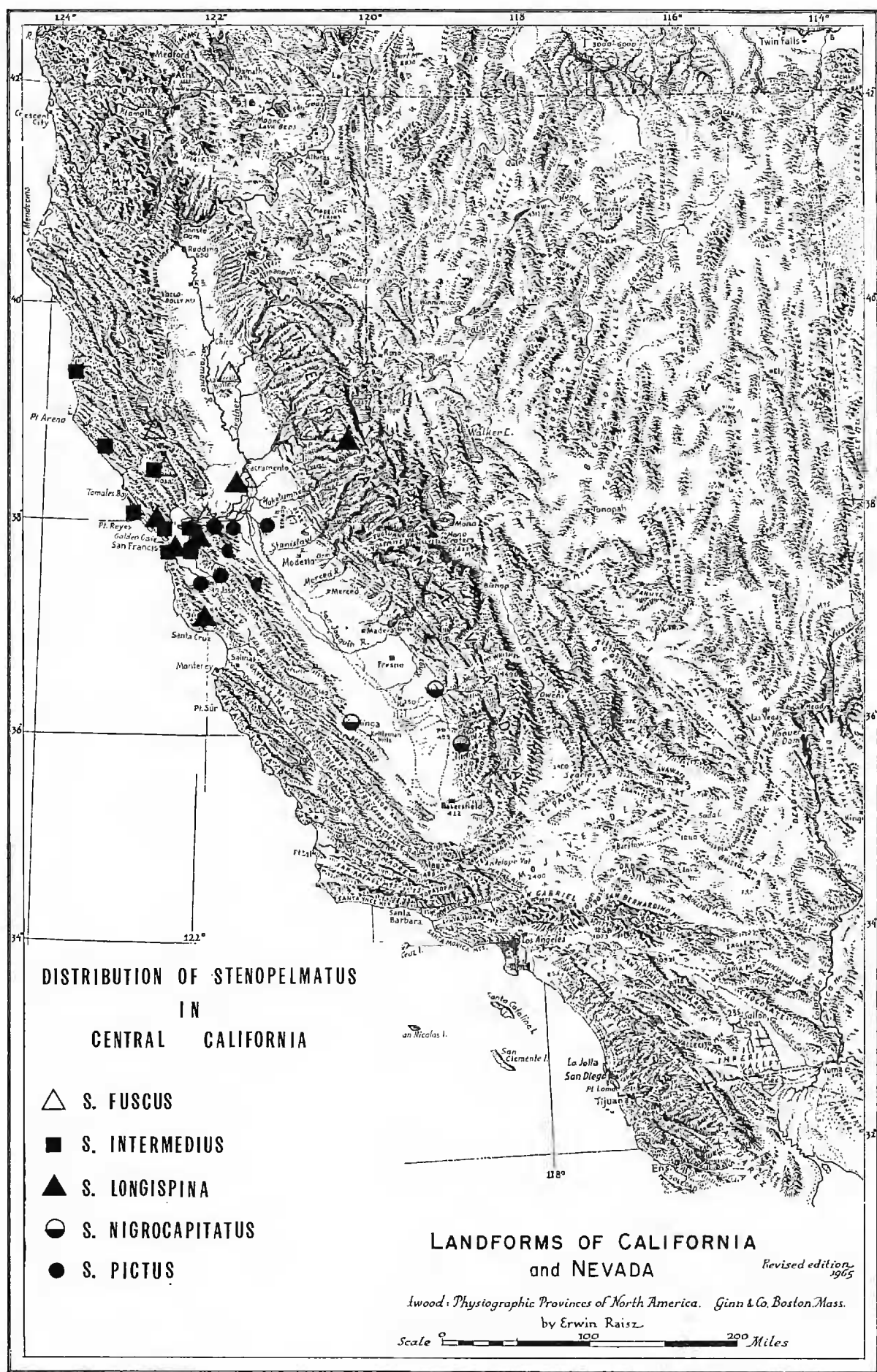


FIG. 1. Distribution of *Stenopelmatus* species in central California. (See text.)

and appears to be most common in the northern portion of the San Joaquin Valley and western foothills of the Coast Ranges. It is possible that the type of the latter species is mislabelled since the second author has lived his entire life in the San Francisco Bay Region and has collected species of Jerusalem crickets since boyhood. At no time was *S. pictus* taken and there are no records of it occurring there in any of the collections studied.

When the seasonal distribution of mature or nearly mature specimens is plotted, seasonal isolation is also indicated. Table 1 shows the resulting chart when adult or subadult males and certain females are used to plot the seasonal distribution. It is interesting to note that when the relatively extensive collections listed above were studied it was found that more than half the specimens examined were immature. The table is therefore composed from a rather small number of specimens. Mature females may live considerably longer than males if for no other reason than the cannibalistic habits of certain females (to be discussed under mating habits). Table 1 is based largely on males since this likely gives a better indication of the breeding period.

#### MATING BEHAVIOR IN SPECIES OF STENOPELMATUS

Although Davis and Smith (1926) observed mating of both *S. intermedius* and *S. fuscus*, they gave no detailed description of their differences and similarities. They did note that in *S. intermedius* the male pursues the female prior to mating and in *S. fuscus* the reverse was true. The specimens they referred to as *S. fuscus* may in fact have been *S. longispina*.

The second author twice observed mating of Jerusalem crickets, once involving *S. intermedius*, the other occasion involving *S. nigrocapitatus* Tinkham and Rentz, new species. Although no comparisons have been made and it is not known how mating differs specifically from one species to the other, a pattern was seen in the two matings and several phases of the act occurred in both observations. A composite description is given below of events seen to be common to both.

A male and female were placed in a wooden observation "arena." On several occasions cannibalism occurred promptly. This was probably due to one or both of the partners not being mature. Immediately upon detecting the presence of an acceptable mate, the male drummed his abdomen against the substrate creating an audible sound. This abdominal drumming can be noted when adult males are kept in jars or cages with plenty of soil. They form burrows and drum against the sides, apparently to attract females. This habit is also observed in



FIG. 2. *Stenopelmatus pictus*. FIG. 3. *S. nigrocapitatus* Tinkham and Rentz, new species.

*Gammarotettix*, an arboreal raphidophorine of the same family which drums against branches and leaves. If receptive, the female *Stenopelmatus* responds by searching for the male. The male also actively seeks the female using his palpi and drumming while searching. In addition to the drumming of the male, his abdomen pulsed laterally almost continually during this period.

Upon encountering one another what appeared to be a mortal combat began. Clicking of the mandibles of the male and occasionally of the female was very noticeable at a distance of up to four feet. The female's mandibles were agape during most of the encounter as if in defensive position, but at no time did she attempt to attack the male. Both sexes clasped the legs of the other with the mandibles but there was no visible damage at all seen when incompatible pairs were placed together. These brief "wrestling matches" occurred three to four times prior to actual mating. They lasted from a few seconds up to a minute after which the pair would separate, run away, and then commence searching for one another again. Attainment of the proper mating position seemed to be lacking in all of these instances.

Successful copulation was accomplished with male atop female, facing her posterior, grasping the hind legs (left in cases observed) in his mandibles. The abdomen of the male then curled to meet her genitalia. During the entire act the hind legs of the male were placed dorsally between the middle and hind legs of the female at their bases. At the instant of genitalic contact, the male ejected a fleshy sac possessing finger-like appendages. A white milky substance, the spermatophore was then affixed to the genitalia of the female; the male pumped fluid onto the female's posterior. A good portion of his abdomen seemed to be emptied during this process. Pulsations of the abdomen of the male were most noticeable at this time. The copulation period lasted for approximately five minutes after which the pair separated and moved a short distance away. Shortly the female began eating the external visible portions of the spermatophore.

After one copulation of *S. nigrocapitatus* the male was immediately attacked by the female and partially devoured. We believe that this happens frequently in nature. This would seem to explain the great scarcity of adult males both in collections and in the field.

The evolutionary significance of a single mating per male is as yet unclear. Were it not for the multi-annual life history, this could geographically limit the populations. A detailed investigation of the internal reproductive system of the male would likely determine whether multiple matings are likely to occur.

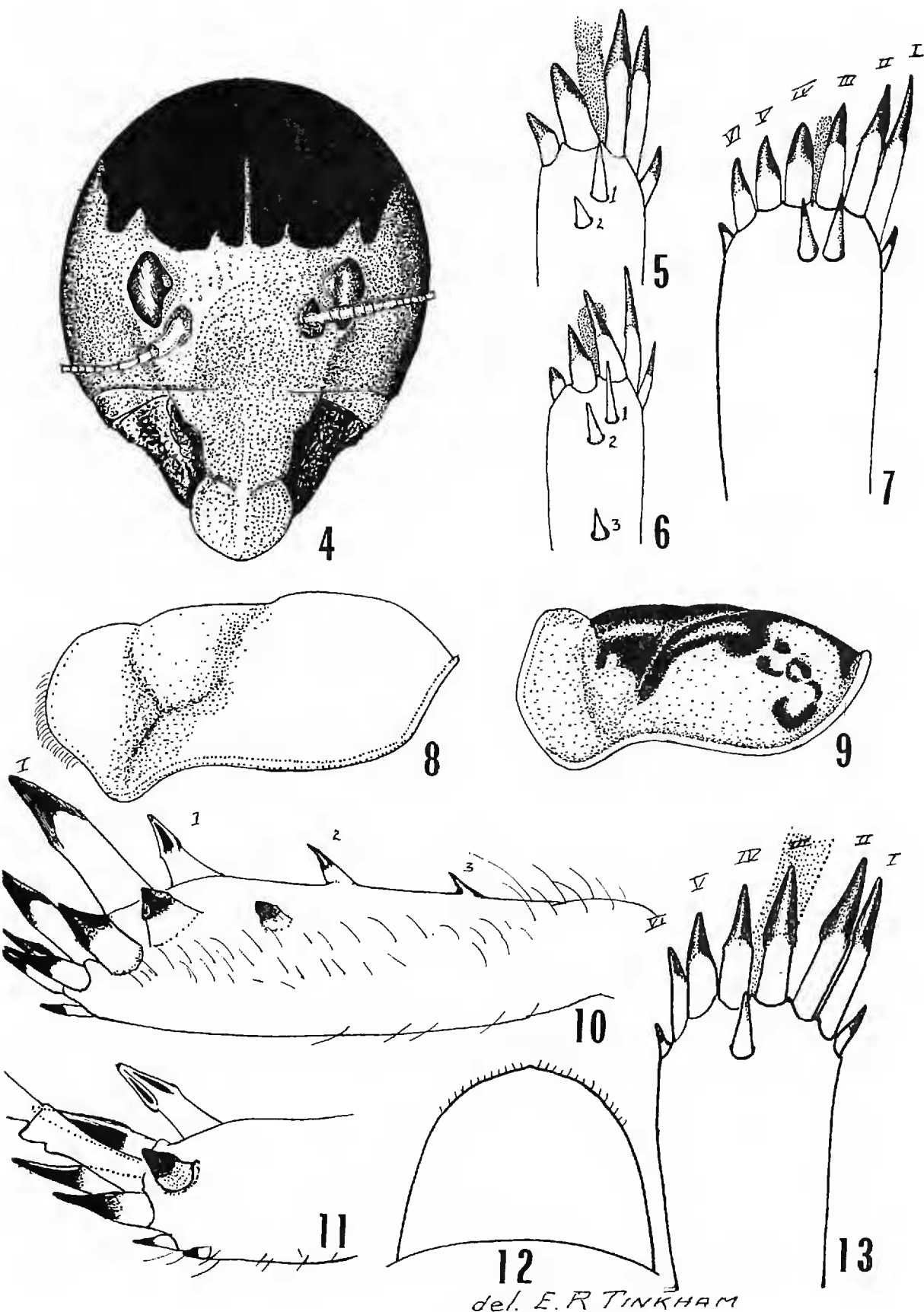


FIG. 4. Front view of head of *S. nigrocapitatus* Tinkham and Rentz, new species, holotype male. FIG. 5. Ventral fore tibia allotype *S. nigrocapitatus* Tinkham and Rentz, new species; note apical spurs and calcars of right leg. FIG. 6. Ventral view fore tibia *S. pictus*, from Stockton, Calif.; note one pair of apical and subapical teeth and calcars of right leg. FIG. 7. Ventral view hind tibia *S. pictus*, Stockton,

KEY TO ADULT AND SUBADULT STENOPELMATINE  
CRICKETS OF CALIFORNIA

1. Tibial spines vestigial or lacking on apical dorsal margins of hind tibia.  
Ringlelet of six apical calcars of hind tibia equal in length, broadly spatulate, suited for arenicolous habitus. Median or presubapical spur on ventral surface of fore tibia absent. Pronotum not expanding anteriorly. Coloration uniformly orange. (Kelso Dunes, San Bernardino County, California.) ..... *Ammopelmatus kelsoensis* Tinkham
- Tibial spines prominently developed on apical dorsal margin of hind tibia.  
Ringlelet of six apical calcars of hind tibia unequal in length, conical or subconical in form, innermost calcar longest (figs. 7, 13). Median or presubapical spur on ventral surface of fore tibia present (except in *S. nigrocapitatus* Tinkham and Rentz, new species). Pronotum expanding anteriorly concealing posterior portion of the large head. Coloration usually dark, especially on abdomen. (Widely distributed in the western United States and Mexico.) .... *Stenopelmatus* Burmeister (2)
2. Fore tibia bearing only two ventral apical spurs posterior to calcars III and IV (fig. 5). Hind tibia usually with a single ventral apical spur (if two, the second very minute) positioned immediately anterior to calcars III and IV (fig. 13). Occiput uniformly dark black in adults and late instars (figs. 3, 4). Pronotum reddish .....  
..... *Stenopelmatus nigrocapitatus* Tinkham and Rentz, new species
- Fore tibia bearing three ventral apical and subapical spurs posterior to calcars III and IV (fig. 6). Hind tibia with two median equal, ventral apical spurs of equal length immediately proximal to calcars III and IV (fig. 7) ..... 3
3. Adult size very large (35–50 mm in body length). Color of head and pronotum orange red. Head often megacephalic ..... 4
- Adult size medium to small (usually less than 35 mm in body length). Color of head and pronotum not orange red but piceous or shining black, the black isolated into irregular areas by pale sutures ..... 5
4. Calcars of the hind tibia forming a semi-ringlelet of six long spurs, the innermost two longer, cylindrical in form ..... *Stenopelmatus longispina* Brunner
- Calcars of the hind tibia forming a semi-ringlelet of six spurs, these spatulate or trowel-shaped on inner faces, the inner three relatively equal, but longer than three outer spurs ..... *Stenopelmatus fuscus* Haldeman
5. Entire head and body uniformly dark brown with black abdominal tergites.  
Hind tibia with four to five internal and two to three external apical

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Calif.; note apical pair of spurs and six calcars. FIG. 8. Lateral view of pronotum *S. nigrocapitatus* Tinkham and Rentz, new species. FIG. 9. Lateral view pronotum *S. pictus*. FIG. 10. Lateral view hind tibia of holotype male *S. nigrocapitatus* Tinkham and Rentz, new species. FIG. 11. Lateral view fore tibia holotype male *S. nigrocapitatus* Tinkham and Rentz, new species. FIG. 12. Ventral view subgenital plate holotype male *S. nigrocapitatus* Tinkham and Rentz, new species. FIG. 13. Ventral view hind tibia holotype male *S. nigrocapitatus* Tinkham and Rentz, new species.

dorsal teeth ..... *Stenopelmatus intermedius* Davis and Smith  
 Upper part of head shining black with tan sutural areas. Pronotum dorsally with irregular areas of shining black. Outer face of femur with pale brown fasciations (fig. 2). Hind tibia with three to four internal and two external apical dorsal teeth (fig. 7) .....  
 ..... *Stenopelmatus pictus* Scudder

### ***Stenopelmatus nigrocapitatus* Tinkham and Rentz, new species**

(Figs. 1, 3-5, 8, 10-13, Table 1)

DIAGNOSIS.—Hind tibia usually with single, median, ventral, apical spur immediately basad or proximad to the base of calcars III and IV. A minute second spur may be present. In all other species of the genus there are two median ventral spurs. The fore tibia is distinctive in having only two apical spurs unequal in length, one slightly basad of the other. All other Californian species possess in addition, a ventral subapical spur placed just beyond the median portion of the ventral surface of the fore tibia.

HOLOTYPE MALE.—(Measurements in millimeters made with Golgau callipers.) Body length 28.2; width of head  $8.7 \times 11.7$  in total depth; pronotum 6.1 long  $\times$  8.8 wide; hind tibia  $10.0 \times 2.6$  wide.

Form typical, medium in size for genus. Head typical of genus, depth of head from occiput to upper margin of ocular breadth (4.7 mm) measured at narrowest points. Eyes inverted, pyriform, slightly prominent, similar to *S. fuscus* and *S. longispina*. Head in other structural features typical of other *Stenopelmatus* species.

Thorax typical in form. Pronotum not ampliate forward as in *S. longispina* and *S. fuscus*, lateral margins not at all broadened at the ventrad projecting bulge on anterior lateral third of pronotum. In lateral profile, dorsum of pronotum arcuately humped in posterior five-sixths, only slight evidence of median suture or groove as seen in paratypes. Anterior margin of pronotum gently emarginate, typically fringed with fine decurved hairs. Posterior margin slightly less emarginate than anterior margin.

Supra-anal plate of abdomen broadly triangulate with typical uncinata hooks at lateral bases. Cerci acuminate, erect, pubescent. Subgenital plate broadly spatulate.

Fore legs, with femur in lateral profile, with upper margin strongly arcuate, ventral margin very slightly arcuate, without spination. Fore tibia unspined dorsally with typical apical calcars, three inner long, two outer short, dorsal external shortest. Ventral surface of fore tibia with two, unequal apical spurs, distal spur larger.

Median femora typical. Median tibia with five calcars (smaller than those of fore tibia), preceded by two apical spurs of similar size, placed approximately in apical two-thirds of dorsal margin. Ventral surface with pair of apical spurs (only one on one tibia), smaller than calcars, placed at base of calcars III and IV.

Hind legs typical in form. Femora unarmed. Hind tibia with six apical calcars, increasing in size gradually from outer-external to innermost calcar. Dorsal surface with three outer apical and subapical spines, three inner ones more widely spaced, apical internal spines with apices even with external apical spur. Number II spur subequal to number III. Basal spur small, slightly proximal of center. Ventral

surface of tibia with only one apical, distinctive spur situated at base of and between calcars III and IV (one hind tibia with additional minute spur).

ALLOTYPE FEMALE.—Total length to apex of ovipositor 31.0; length to base of ovipositor 29.1; pronotum 4.75 long  $\times$  7.0 wide; hind femur 8.1 long  $\times$  3.4 wide; hind tibia 12.2  $\times$  2.0 wide.

Allotype similar to holotype except as follows: size larger, abdomen with supra-anal plate and cerci smaller; subgenital plate very shallowly and broadly triangular with acute apex; ovipositor typical, short, recurved, unarmed; median tibia with pair of apical ventral spurs, hind femora similar to holotype. Hind tibia with single apical ventral spur on each leg.

TYPE DATA.—*Holotype male* and allotype, JACALITOS CANYON 6 MILES SSW OF COALINGA, FRESNO COUNTY, CALIFORNIA, 27 January 1961, D. C. Rentz, collector.

TYPE LOCALITY.—The type locality is a portion of the Jacalitos uplift, an area of Paleocene sediments. It is under exploitation by oil companies at the present time. The species seems restricted to the areas where sandstone occurs and is found under such rocks especially at the bases of hillsides. The Jacalitos uplift extends to the north for some 50–75 miles and this species should be looked for in these areas. Type deposition. The holotype and allotype are deposited in the California Academy of Sciences, number 10,120.

PARATYPES.—Same locality data as holotype but with following dates and collectors: 4 ♂♂, 18 ♀♀, 27 January 1962, D. C. Rentz, J. R. Helfer, collectors; 7 ♀♀, 1 February 1962, D. C. Rentz, R. Bandar, collectors. Additional paratypes from Fresno County as follows: Jacalitos Creek road, Rocky Buttes, 20 February 1960, 1 ♀, H. L. Wilson. Near Coalinga, 31 March 1960, 2 ♀♀, H. L. Wilson. Coalinga, Oil City, 18 March 1931, 3 ♀♀, E. C. Van Dyke.

RANGE OF VARIATION.—Eleven females were measured by the first author and range as follows: body length 22.6–28.6; pronotum 7.8–8.1 wide  $\times$  4.8–5.2 long; hind femur 7.5–9.2; hind tibia 7.6–8.2  $\times$  1.4–1.8 mm. Some paratypes, as seen in fig. 3, have the pronotum with brownish areas but never developed as in *S. pictus* (fig. 2). Paratypes are deposited in the authors' collections, California Academy of Sciences, and J. R. Helfer collections.

A single female, likely adult, from Visalia, Tulare County, California, collected on 25 November 1948, W. D. Murray collector, could possibly represent this species. The specimen is pinned and poorly preserved. The head and pronotum are similar to the species herein described but the calcars of the hind tibiae are a bit shorter, perhaps due to wear. Another specimen, a female from Hot Springs, Tulare County, California, 15 April 1938, collected by E. C. Van Dyke is definitely this species and demonstrates that the species occurs on the fringes of the San Joaquin Valley.

## LITERATURE CITED

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**A New Species of *Pseudocloeon* from Idaho<sup>1</sup>**

(Ephemeroptera : Baetidae)

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While studying the mayflies of Idaho, I found two male imagos that represent an undescribed species of *Pseudocloeon*. I take extreme pleasure in naming this species for Dr. George F. Edmunds, Jr., in recognition for his many contributions to the study of Ephemeroptera. I express my appreciation to Mr. Arwin Provonsha for aid in preparing the illustrations.

***Pseudocloeon edmundsi* Jensen, new species**

MALE IMAGO (in alcohol).—Length: body 4.5-5.0 mm; forewings 4.5-5.0 mm. General color light brown. Head light brown; antennae light brown basally, pale apically; ocelli white; compound eyes divided, upper portion turbinate, separated dorsally at midline, pinkish-tan, lower portion black (figs. 1-2). Thoracic notum reddish-brown; pleural sclerites light reddish-brown, membranes white; thoracic sterna light reddish-brown. Forewings hyaline, stigmatic region cloudy white, longitudinal and crossveins hyaline, stigmatic crossveins slightly anastomosed (fig. 3); hind wing absent. Legs white, faintly brown at apex of tarsi. Abdominal tergum 1 subhyaline light brown; terga 2-6 subhyaline white with very faint black spiracular markings; terga 7-10 light tan, opaque. Abdominal sterna 1-6 same color as terga; sterna 7-9 white, opaque; subgenital plate and forceps white (fig. 4). Caudal filaments white.

TYPES.—*Holotype male imago*, SNAKE RIVER AT U. S. HIGHWAY #20-26, 8 MILES NW. PARMA, CANYON COUNTY, IDAHO, 29 August 1958, G. F. Edmunds, Jr., and R. K. Allen, in collection of University of Utah, Salt Lake City. Paratopotype: 1 male imago, same data and deposition as holotype.

REMARKS.—*Pseudocloeon edmundsi* is the fourth species in the genus known from western North America. The other three species, *P. futile* McDunnough, *P. rubrolaterale* McDunnough, and *P. turbidum* McDun-

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